How Do Seasonal Temperature Patterns Vary Among Different Regions of the World?

Purpose

Students use GLOBE visualizations to display student data on maps and to learn about seasonal changes in regional and global temperature patterns.

Overview

Students use the GLOBE Student Data Archive and visualizations to display current temperatures on a map of the world. They explore the patterns in the temperature map, looking especially for differences between the Northern and Southern Hemispheres, and between equatorial regions and high latitudes. Then students zoom in for a closer look at a region which has a high density of student reporting stations (such as US and Europe). They examine temperature maps for the region, from four dates during the past year (the solstices and equinoxes). Students compare and contrast the patterns in these maps, looking especially for seasonal patterns. At the end of the activity, students discuss the relative merits of different types of data displays: data tables, graphs and maps.

Time

Approximately three class periods

Level

Grades 3-12

Key Concepts

- Temperatures vary from one location to another around the world.
- Global temperatures patterns vary from one season to the next.
- Local latitude, elevation and geography affect seasonal temperature patterns.
- Current weather conditions affect regional and global temperature patterns.

Skills

- *Mapping* data with the GLOBE Student Data Server to explore seasonal temperature patterns
- *Comparing* graphs, maps and data tables as tools for data analysis

Materials and Tools

- Access to the GLOBE Data Server
- A map of the world
- Acetate and markers (optional, so students won't mark directly on maps)

Preparation

You may want to display, print and make copies of the maps before class.

Prerequisites

We recommend that students first do *What Are Some Factors That Affect Seasonal Patterns?*, so that they have experience with using graphs to explore seasonal changes in data from individual schools, and so that students have a basic understanding of factors affecting seasonal changes in temperature.

Background

In this activity, your students use GLOBE's visualization tools to explore seasonal patterns in global and regional temperature data. This serves two purposes. First, students learn about seasons in a global context. Second, students learn how to use GLOBE's mapping tool to see global patterns in GLOBE student data.

Special Note: Some regions do not yet have enough reporting stations for thorough analysis.

For the time being, there are regions of the world (such as the United States and Europe) which have large numbers of schools reporting data, whereas other regions have fewer stations. Therefore, when you look at GLOBE visualizations, you will find some areas of the world with ample data for the types of analyses described here, whereas other areas may be too sparse for adequate analysis. Recognizing this temporary constraint, this activity includes both global studies (using the full scope of GLOBE reporting schools) and regional studies (which focus on areas with many reporting sites). Eventually, as GLOBE grows, your students will be able to do more and more global studies.

Mapping Data with the GLOBE Visualization Tool

Please refer to the color maps displayed in Figure SE-L-10 through SE-L-17. GLOBE's visualizations display student data in maps. These visualizations are especially powerful tools, and can be used to help students conduct a variety of investigations. In essence, you select the region that you want displayed, the type of data, and a date and time. Then the GLOBE software creates the requested map, and sends it to you over the Internet.

There are two types of maps that can be displayed: dot maps and contour maps

Figure SE-L-10 is a dot map. This shows each reporting school as a colored dot. The color of the dot corresponds to the value reported by the school. This type of map is best when you want to know where the reporting schools are located, and get a sense of the individual data values (as represented by the color).

Figure SE-L-11 is a contour map. This map uses the raw data to create contours, such as the temperature bands in the example. This type of map is best when you want to explore patterns in the data. You can use the color key to find out what values are indicated by each band. Also, there may be regions of the map without contours. These are areas in which there are no reporting stations.

For these activities, we recommend contour maps because we are more interested in the patterns than in the actual values. Your students will focus primarily on the shape of the temperature bands (noting, for example, where a given band dips down toward the equator).

Your students may quickly learn how to work with contours, since these are the same types of temperature maps that appear in newspapers and on TV, and appear in science textbooks. If your students are confused, you might want to have them work with a data map to make their own contour map. First, use crayons to circle all the points in each temperature range (for example, use red to circle all points with a temperature of 20-29, blue for temperatures 30-35, etc.). Then have your students use crayons to draw bands connecting the points that are the same color.

Temperatures Vary from One Location to Another Around the World

Your students begin by displaying current temperatures, as reported by students around the world. For example Figure SE-L-12 shows a map of student data from all currently reporting schools. In the activity, you will have students explore the map, looking for global patterns. In this example, notice that:

1. There are gaps in the data, because some parts of the world do not yet have GLOBE schools. The world coverage will improve over the years.
2. Since the data are from December, the Northern Hemisphere is generally cooler than the southern hemisphere
3. There are variations in the temperature patterns based on current weather and

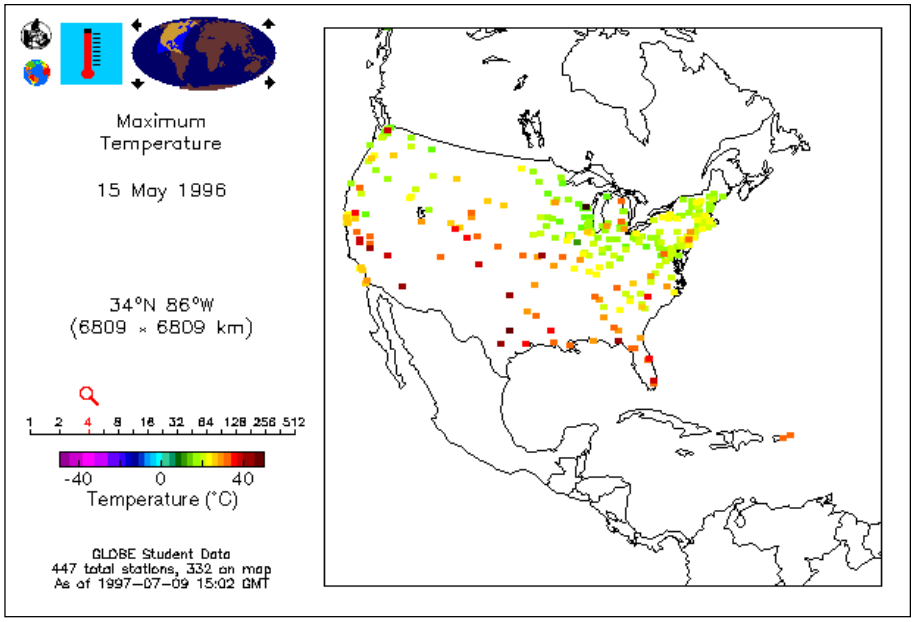

Figure SE-L-10: GLOBE Dot Map of Maximum Temperatures in the U.S., on May 15, 1997

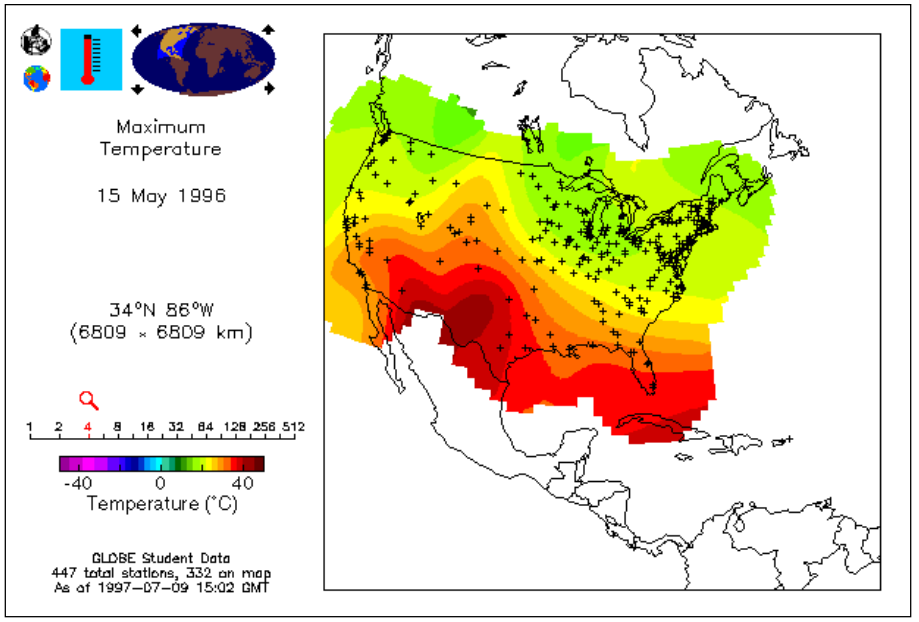

Figure SE-L-11: Same GLOBE Data as a Contour Map

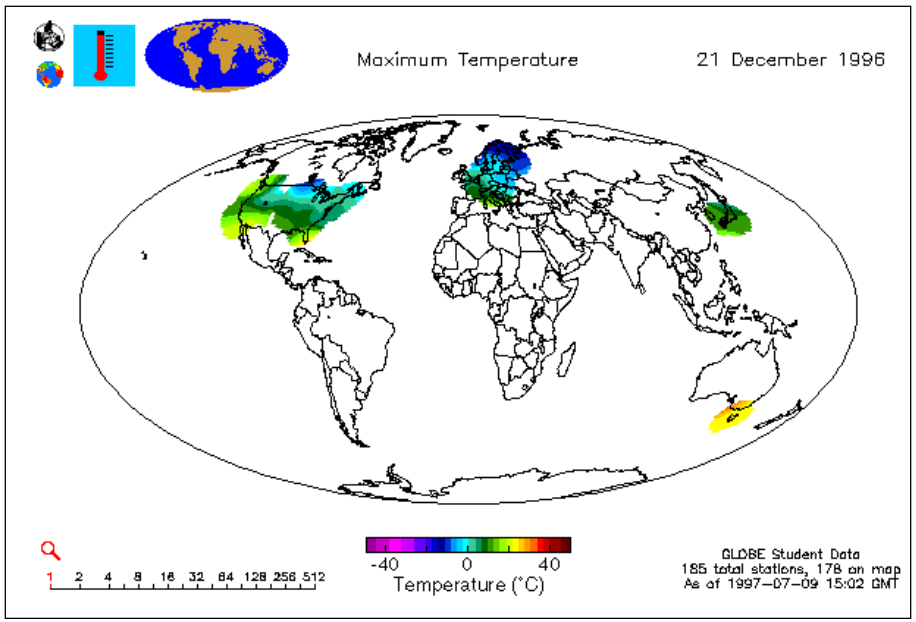

Figure SE-L-12: World Temperature Patterns on December 21, 1996 (These maps will become more complete as additional GLOBE Schools begin submitting data.)

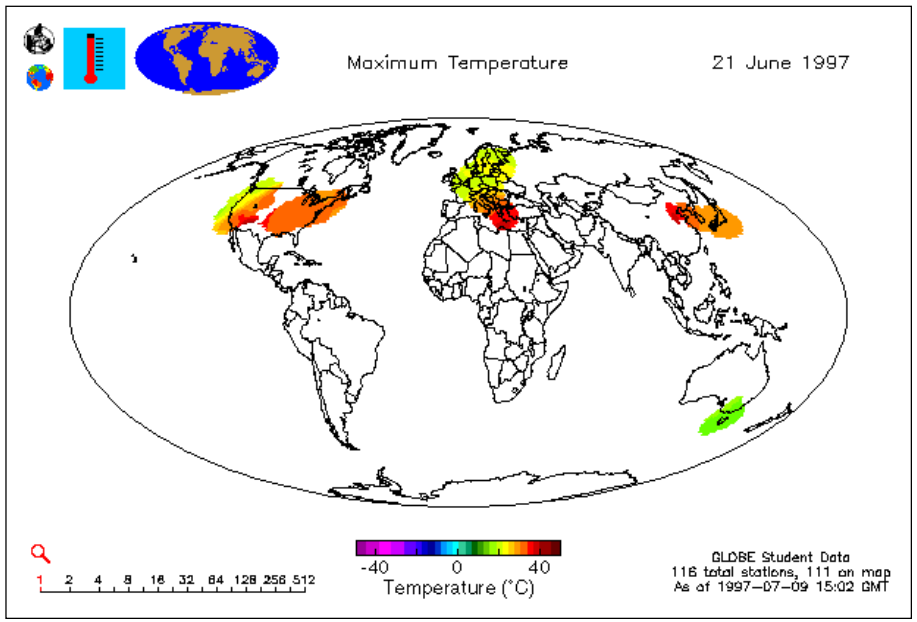

Figure SE-L-13: World Temperature Patterns on June 21, 1997

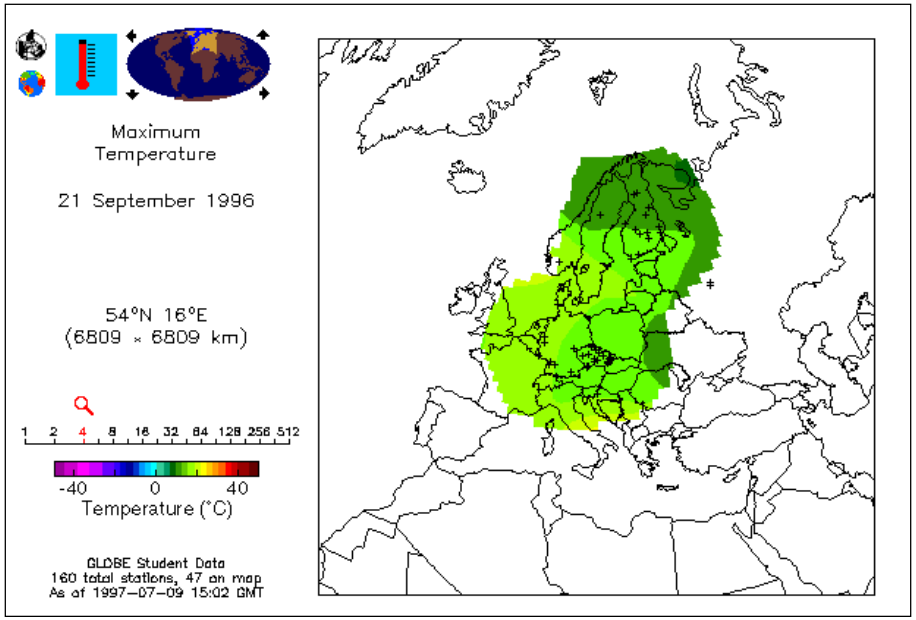

Figure SE-L-14: Europe Temperatures in the Fall - September 21, 1996.

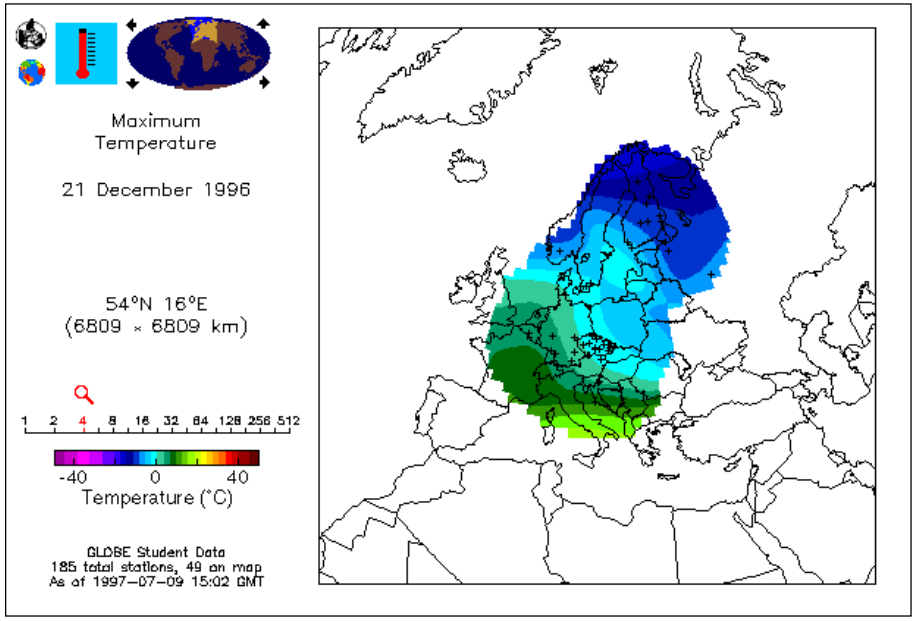

Figure SE-L-15: Europe Temperatures in the Winter- December 21, 1996.

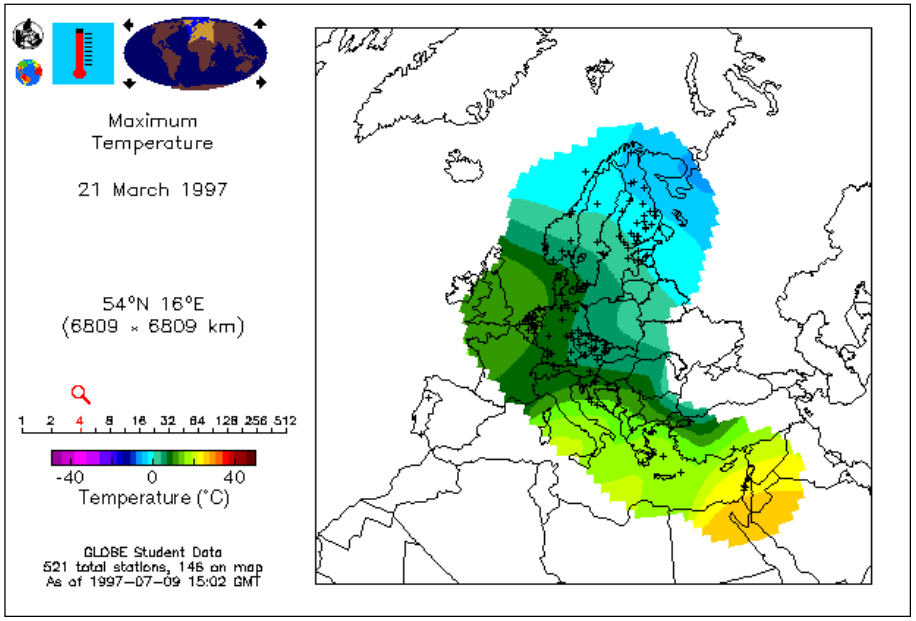

Figure SE-L-16: Europe Temperatures in the Spring - March 21, 1996.

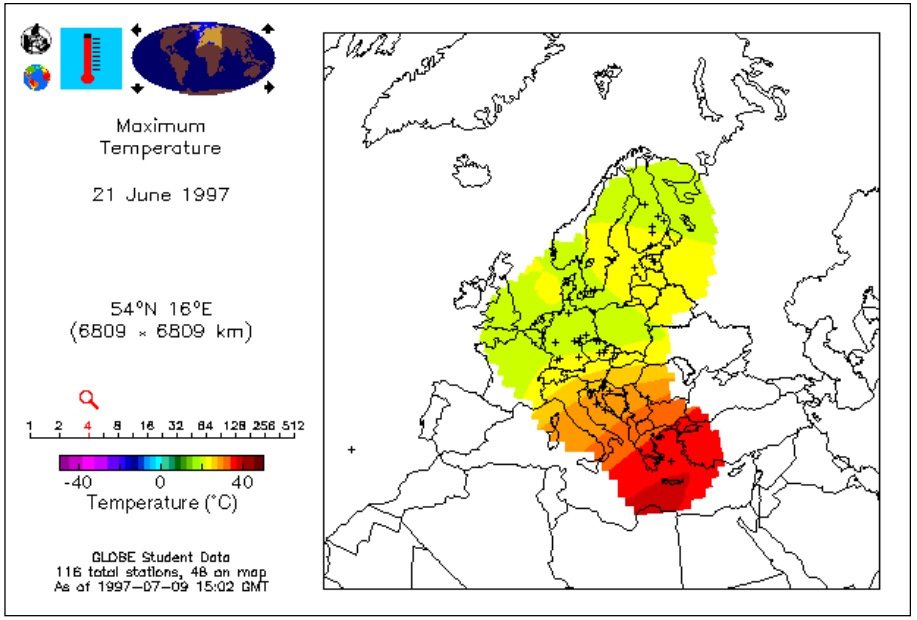

Figure SE-L-17: Europe Temperatures in the Summer - June 21, 1996.

local climatology (e.g. France is warmer than Northeastern U.S., even though they are both at the same latitude)

Temperature Patterns Vary from One Season to the Next

When your students display temperature maps from four different days throughout the year, they are able to explore the seasonal variations in global temperatures, as shown in the above sample maps. (For more detailed analysis, your students could display data from each month of the year).

In these sample maps, Figures SE-L-14 through SE-L-17, notice that:

1. It is generally warmer in the summer and colder in the winter.
2. Fall and spring are similar in temperature.
3. Regardless of season, it is warmer the farther south you look.

Regional Maps Show Greater Detail in the Temperature Patterns

When you zoom in for a closer look at a region of the world, you can see more detail. This enables you to see regional patterns more clearly. In Figure SE-L-14 through SE-L-17, you can see the differences among four different views, each representing a different season. For example:

1. Temperatures are generally warmer in the summer than the winter.
2. Weather patterns are not constant throughout the year (for example, the curves in the temperature contour on June 21 is not the same as on Sept. 21).

Your students can extend the investigation by looking at seasonal variations in other types of data, such as precipitation type and amount, soil moisture or water temperature. Your students can also explore how the local variations are affected by local geography and elevation.

What To Do and How To Do It

Note: These activities work best if students gather around the computer or take turns, so that they can work directly with the GLOBE visualizations. Or you can print the GLOBE maps and make copies for each student or for groups of students.

Step 1: Display a map of recent temperatures world-wide.

Use the GLOBE data system to access recent temperature data (either minimums or maximums) from all student sites around the world, and display the data on two types of maps: data map and contour map. You might want to choose yesterday's data, since some schools may not yet have reported today's data.

Step 2: Students explore the global temperature maps.

Begin with the dot map. Have your students examine the map. First look for your own site. This shows the temperature data reported by your school. It is shown as a colored dot, with the color corresponding to the temperature. Next, look for other sites, and compare their location and temperature with your own. Find other schools with the same temperature (color) as your own. Find other schools in your own country. Find a school in each continent. Then find the absolute warmest location, and the absolute coldest location.

As noted in the background section, you will see that some areas have many GLOBE schools reporting data, and other areas have few or none. As more schools begin reporting data, your students will be better able to see global patterns. You can use this opportunity to help your students see the importance of having many schools world-wide and having each report their data every day.

Next, have your students look for global patterns in the temperature data. Your students might notice that:

1. Temperatures are warmer in equatorial regions, and colder as one moves further north or south.
2. The Northern Hemisphere is warmer than the Southern Hemisphere or vice-versa.

Step 3: Students zoom in for a local view, and explore regional seasonal variations.

Ask your students what they think the global temperature map will look like at different times of the year. This can be a useful discussion, helping students to think about global seasonal patterns, and to make their own predictions. It also helps you as teacher to find out what your students know and what misperceptions they might have.

Tell your students that they will now zoom in for a closer view of one or more regions of the world. Have them select areas of the world where there are many data points, and then request a contour map for that region. Make sure your students understand what the contour map shows (same data as in the data map, but presented as temperature bands). Ask them what shapes and patterns they see in the contour map.

Now select maps of the same region, from four different dates during the year. This will enable them to examine how the temperature patterns change over the year. Ask your students what four days would give a good cross-section of the year. Discuss your students' suggestions. Either proceed with whatever dates they suggest, or guide the discussion to selecting the four seasonal transition points (June 21, Sept. 21, Dec 21, Mar 21). You might want to discuss the significance of these dates (solstices and equinoxes). Another approach is to select 12 dates, one per month. This will give your students more detail in the year-long variations.

Access, display (and if possible print and make copies of) the temperature map for each of the four days.

Now have your students study the maps. What similarities do they see from one season to the next? What differences? You want to promote student inquiry and investigation here, so don't simply tell them what the patterns are, but let your students explore the maps and discuss individually or in small groups.

Discuss what they found. They are likely to see:

1. One season tends to be warmer than another.
2. Regardless of season, it tends to be warmer as one moves closer to the equator.
3. Weather patterns are not constant throughout the year. The shape of the temperature bands will vary from one day to the next.
4. If you look at schools in the same latitude, you will find differences in their temperatures.

Ask your students why these patterns occur. For example, they may understand that the northern and southern hemispheres have opposite seasons. Or they may comment that local weather conditions impact on the seasonal variations (coastal regions tend to have more stable temperatures throughout the year.)

Step 4: Students compare and contrast data tables, maps and graphs. See Figure SE-L-18 through SE-L-20.

In this activity your students use GLOBE maps. In other activities, students use graphs and in others they use data tables. These three types of data displays enable your students to visualize, understand and interpret the data. At this point, it is worth exploring with your students the merits and applications of these three types of data displays.

Show your students these three types of data displays. Ask your students what type of information they see in each display. Then discuss with your students the advantages and disadvantages of each type of display.

For example, your students might notice that:

Maps show how data varies from one location to another. You can see world-wide or regional patterns such as the warmer temperatures in the equatorial regions of the world.

Graphs show how data changes over time. You can see annual patterns such as the warmer temperatures in summer and the colder temperatures in winter.

Data tables show lots of data values in a grid. You can quickly find any type of data for any location, such as the temperature and precipitation amount for a given city.

Post a copy of the map, graph and data table on

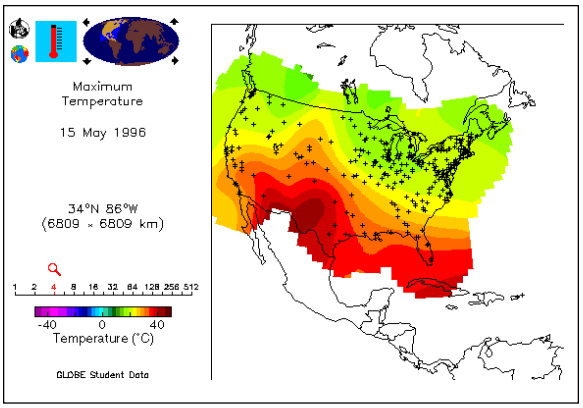

Figure SE-L-18: Maps

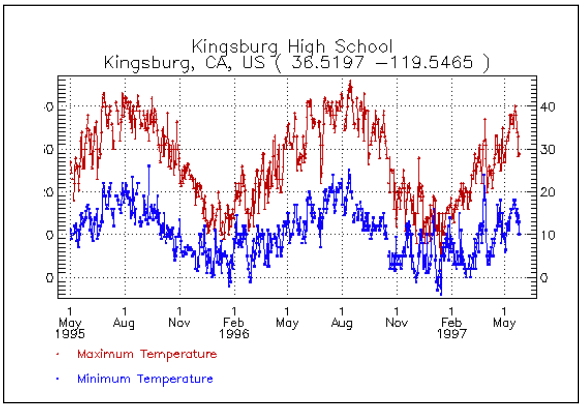

Figure SE-L-19: Graphs

Data for 19970707 to 19970707

Atmospheric Temperature						TEMPERATURE		
MG	YY/MM/DD	HR	LAT	LONG	ELE	CURR	MAX	MIN
AT	97/07/07	20	47.6589	-117.4250	675	24.0	34.0	12.0
AT	97/07/07	19	32.2217	-110.9258	836	36.1	41.7	25.6
AT	97/07/07	19	36.5197	-119.5463	27	34.0	39.0	17.0
AT	97/07/07	19	33.7769	-118.0386	7	24.0	24.5	17.0
AT	97/07/07	19	45.4556	-112.1961	1594	29.0	29.0	7.0
AT	97/07/07	18	33.7769	-118.0386	7	23.0	26.0	16.0
AT	97/07/07	18	40.7608	-111.8903	1711	29.0	34.0	16.0
AT	97/07/07	18	47.6064	-122.3308	67	21.0	-99.0	-99.0
AT	97/07/07	17	57.7883	-152.4030	35	12.0	15.0	11.0
AT	97/07/07	17	35.8422	-90.7042	69	31.0	31.5	17.5
AT	97/07/07	17	39.7683	-86.1581	259	28.0	-99.0	-99.0
AT	97/07/07	17	39.2403	-76.8397	57	30.0	-99.0	-99.0
AT	97/07/07	17	44.8817	-69.4458	88	28.0	30.0	7.5
AT	97/07/07	17	39.7558	-77.5782	375	27.0	27.0	16.0

Figure SE-L-20: Data Table

a bulletin board, and have your students write under each type of display some interesting observations that they see in that display. For example, under the graph they might write the coldest day of the year. Under the map, they might write the coldest location in the world. Then have them write some questions that could be answered with that type of display.

You may need to revisit this comparison of different types of data displays, as students plan their own investigations, such as in step 5 below. Students need to be sure that they're using the most appropriate display for their data analysis.

Step 5: Students use an inquiry-based approach to extend the investigations.

There are several ways that you and your students can extend the investigations. For example:

- Print out maps from two consecutive days (such as June 21 and June 22). Using these two maps, students can explore short term variations versus long-term seasonal changes. For example, they might see minor changes in the shapes of the temperature bands from one day to the next, and larger changes in the overall temperatures from one season to the next.
- Pick two locations for more detailed comparison. For example, your students might find that a town on the Mediterranean coast has less variation between winter and summer than a place in central Canada. This might be because the water of the Mediterranean has a moderating effect on temperature variations. If so, do other coastal locations have similarly moderated temperature variations?
- Display other data on the maps, such as precipitation amount. Students might compare patterns of snowfall in the winter versus the summer and compare northern hemisphere vs. southern hemisphere.

In each of these extensions, be sure your students use an inquiry-based approach, in which students:

1. Begin by exploring the displays to see what patterns and questions emerge.
2. Select a question that seems especially interesting.
3. Decide what resources can help students investigate the question. Especially focus on use of GLOBE data (each of the examples above uses GLOBE data).
4. Conduct the investigation, either individually or in teams.
5. Share the findings with other students.
6. Think about what new questions emerged that could lead to further investigations.

For these investigations to succeed, they need to be genuinely engaging for the students — in other words the student(s) should really care about the answer. One goal of the activities in this seasons module is to stimulate such interests. In that sense, these activities not only have their own intrinsic value, but also serve as launching pads for further investigations.

Assessment

In this activity, your students have learned about seasonal patterns in global temperature data. They also have learned about GLOBE's map visualization tools. To assess student learning, use the following two steps:

1. Ask your students to use the GLOBE data server to create a contour map of student temperature data from July 15 and January 15 (these dates are near the peaks of summer and winter, and are different from the maps they've already used). Check to make sure each student is able do this activity correctly. You might have a student who knows how to do this help you by observing the other students as they go through the steps, to see who knows how to do this, and who has what kinds of problems.
2. If possible print out the July 15 and January 15 maps from the previous step, and make copies for your students. If you can't do this, then use the sample Dec 21 and June 21 temperature maps that appear in the background section. Then have your students indicate which is summer and which is winter. If you wanted to extend the assessment further, you might print out a 6 month sequence from July 15 to January 15 (one map from each month), cut out or cover over the date on each display, and then ask your students to sort them into the proper sequence. Then ask them to write down what evidence they used to put them in this sequence.